

DCATT-MECH-PROC-002

DCATT Hardware User's Manual

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DCATT Project

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PURPOSE

The purpose of this document is to explain how to put DCATT together, how to handle the heavy assemblies, and how to make small adjustments for coarse alignment of the assemblies and optical systems.

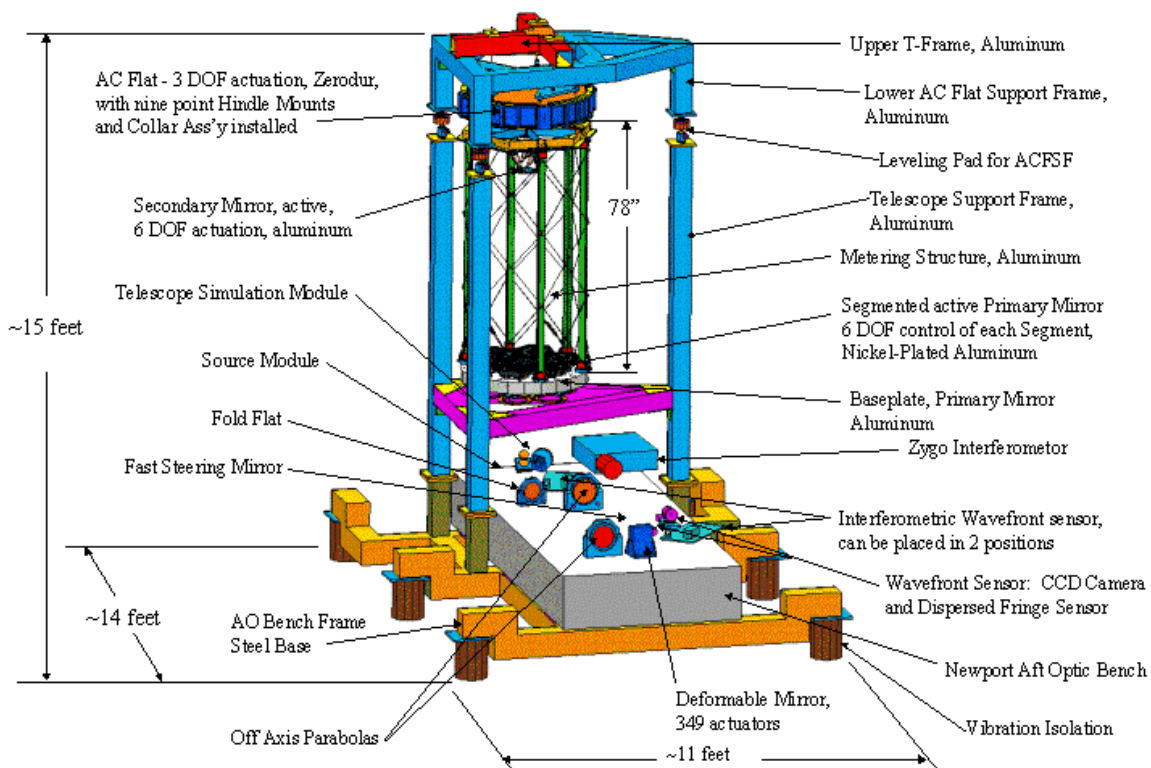


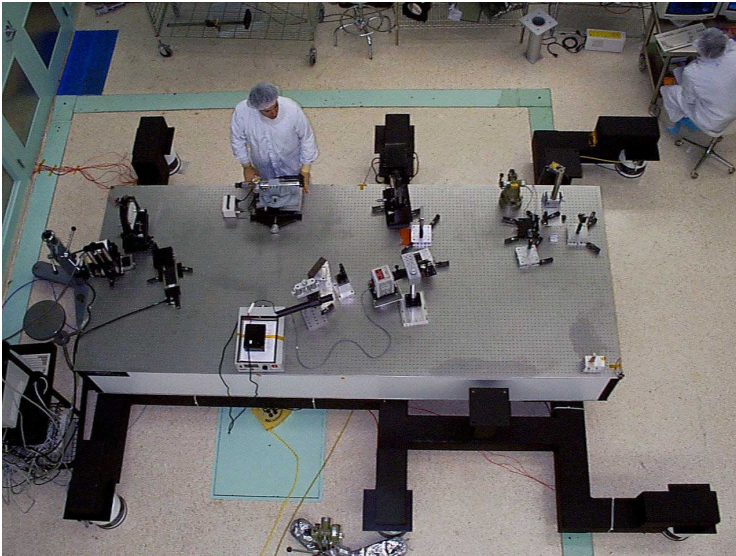
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SETTING UP THE AO BENCH AND PNEUMATIC ISOLATORS

Installing the Aft Optics Bench onto the AO Bench Frame

The Aft Optics Bench is a Newport RS-4000 cleanroom table, 5' wide by 12' long by 18" thick. It weighs approximately 2000 pounds. It rests on the Aft Optics Bench Frame (drawing #2022800) as shown below:



Top view of Bench and Frame after assembly

The general procedure of mating the Bench to the Frame is as follows:

1. Position the AO Bench Frame (weight: 1700 pounds) in the cleanroom in the preferred orientation.
2. Install the six isolator mount plates (drawing # 2022801) to the six outriggers.
3. With the AO Bench frame on jacks or suspended via the crane, install the Newport I-2000 pneumatic isolators by attaching to the isolator mount plates as shown in the picture below:



View of a Newport I-2000 pneumatic isolator, interface plate, and Bench outrigger

4. Attach the 6 mount plates (drawing #2022802) onto the AO Bench Frame at appropriate locations on the frame.
5. Using a crane, lower the AO Bench onto the AO Bench Frame. The Bench should be resting on the 6 mount plates.
6. Attach the AO Bench to the mount plates with screws which are match drilled into the Bench.



Side view of the AO Bench and Frame

AUTOCOLLIMATING FLAT HANDLING PROCEDURES

AC Flat Properties:

Optical flat dimensions: cylinder 40.070" diameter, 7.372" thick.

Mass: 849 pounds

Material: Zerodur or Cer-vit glass

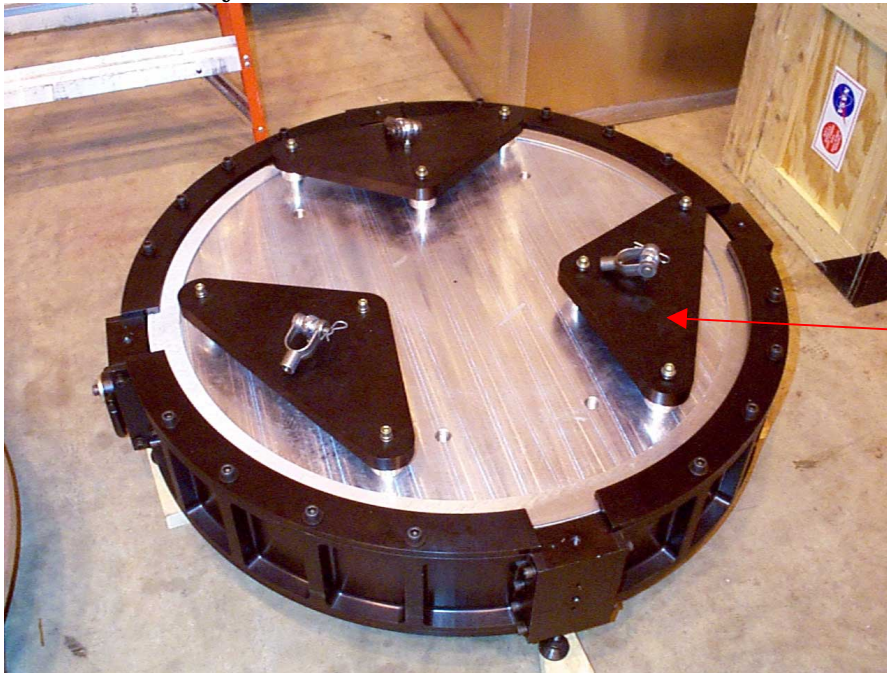
Dimensions of Shipping Crate

Shipping crate outside dimensions: 54.75" x 53.75" x 29.5"

Shipping crate inside dimensions (empty): 52.25" x 51.25" x 19.75"

Installing the AC Flat Collar Assembly

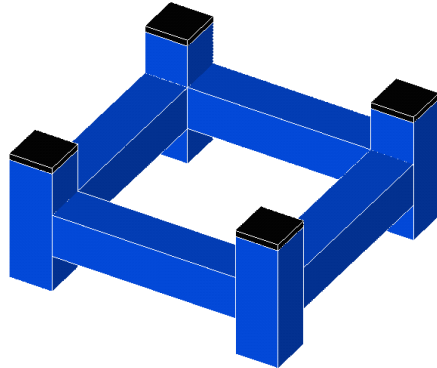
The AC Flat Collar Assembly should always remain around the AC Flat for ease of handling and protection of the mirror. However it can be removed and re-installed if necessary. Below is a picture of the AC Flat with Hindle Mounts and Collar Assembly installed.



AC Flat Collar Assembly with Hindle Mounts and AC Flat

To install the AC Flat Collar Assembly (drawing # 2022779) onto the AC Flat, first the flat should be resting on a wooden pedestal.

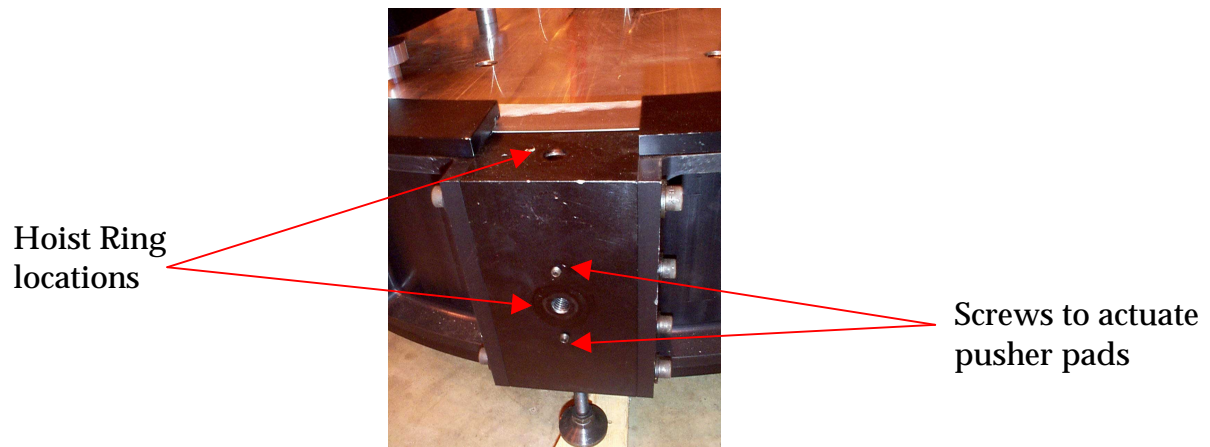
The pedestal allows access to the upper and lower rims of the mirror.



Wooden Pedestal

The pedestals outside dimensions are 22" x 22" x 10.5", with 4" gap under braces (for forklift access). Material: 4"x4" wood beams (3.5"x3.5" actual) with 0.5" thick Buna rubber pads. Note: Wooden beams wrapped in Lumalloy.

The AC Flat Collar Assembly consists of four collar pieces, 4 upper and 4 lower lips, and four corner blocks. Each corner block has two pusher pads.



AC Flat Collar Assembly Corner Block

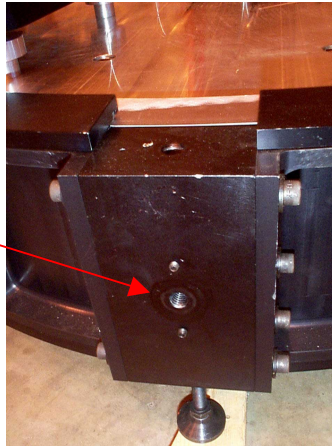
1. If the AC Flat is in the shipping crate, then remove crate top and all four sides.
2. Assemble four collar sections, four corner blocks, and four top lip segments. Each corner block should have two ¼-20 set screws that actuate the pusher pads that position the AC Flat within the collar.
3. With 2 people, lift this subassembly over the mirror and set in place.
4. Install lower lip sections on rim.
5. Tighten the 8 pusher pads so as to lock in the mirror to prevent shifting.
6. Install hoist rings in corner blocks. Also, any of the 40 tapped holes (1/2-13 thread) on the top or bottom of the collar may be used if necessary.

Rotating the AC Flat Collar Assembly

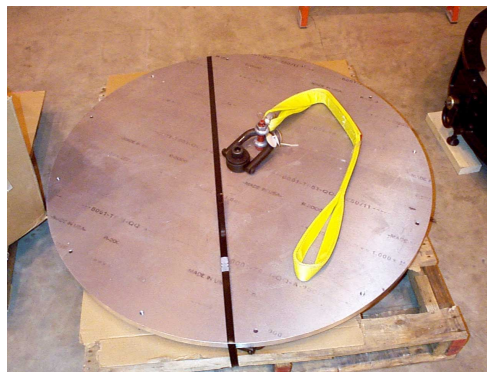
At least once in the life of the AC flat, it will be necessary to rotate it shiny side up to shiny side down. This is accomplished with the Collar Assembly as follows:

1. Assemble the collar assembly around the AC Flat
2. Insert ½-13 hoist rings in two opposite blocks on the collar assembly

Hoist Ring
location



3. Prepare the DCATT Spreader Plate by installing two hoist rings on opposite holes around the perimeter. Attach certified matching nylon lifting slings with certified clevises. The mass of the AC Flat with the Collar Assembly installed is about 950 pounds.

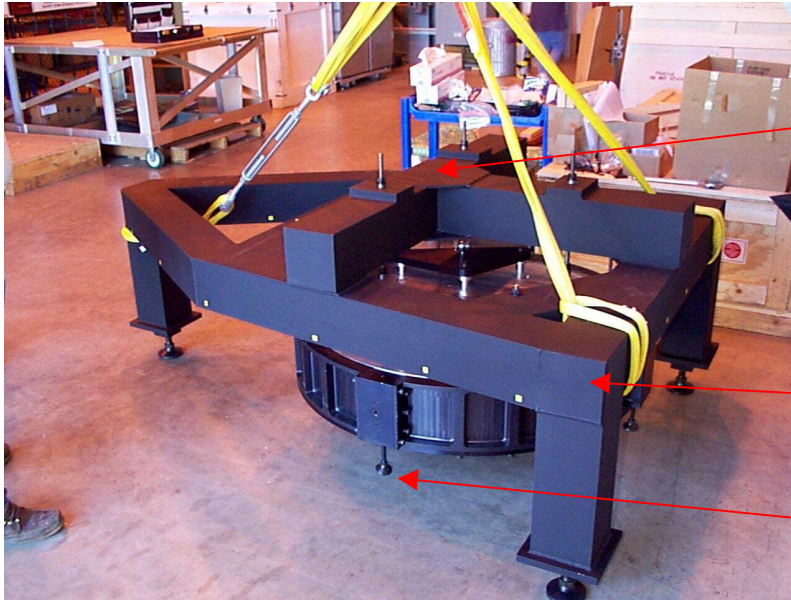


DCATT Spreader Plate

4. Attach the lifting slings to the hoist rings on the collar assembly.
5. Using a crane with the crane hook attached to the center hoist ring (1-8 threadform) of the DCATT Spreader Plate, lift the assembly up at least 4 feet.
6. Rotate the assembly by hand. It should rotate easily.
7. Consider inserting four ½-13 leveling pads into the blocks to make it easy to set the collar assembly down on the floor or table.

AC FLAT SUPPORT STRUCTURE HANDLING

Installing the Collar Assembly into the Support Structure Assembly



Upper
Support
Frame

Lower
Support
Frame

Leveling
pad

Before starting, the AC Flat must have the 9 invar mushrooms epoxied to the back of the AC flat, and the Hindle Mount triangular plates and rod ends installed.

The preferred way to install the AC Flat into the Support Structure is as follows:

1. Start by orienting the AC Flat shiny side down (towards the floor). Leveling pads on the collar assembly are provided to keep the mirror off the floor.
2. Remove the top lip segments on the collar assembly.
3. Orient the Support Structure over the AC Flat and install three 30" long $\frac{1}{2}$ -20 all-thread studs through the Upper Support Frame and into the clevises attached to the rod ends on the Hindle Mounts.
4. Eight $\frac{1}{2}$ " clearance through-holes were put in the Lower Support Frame around the perimeter where the AC Flat attaches. Install four 30" long $\frac{1}{2}$ -20 all-thread studs through four of these holes. The pattern should be as square as possible.
5. Install the four roller bearings around the all-thread studs and then install shoulder nuts.
6. With four people, raise the AC flat to about 1" from the bottom of the Lower Support Frame by rotating the shoulder nuts. This is a slow process which relies on the four people rotating the shoulder nuts at the same rate. If any significant tilting of the AC Flat is noticed, or if any nuts begin to bind,

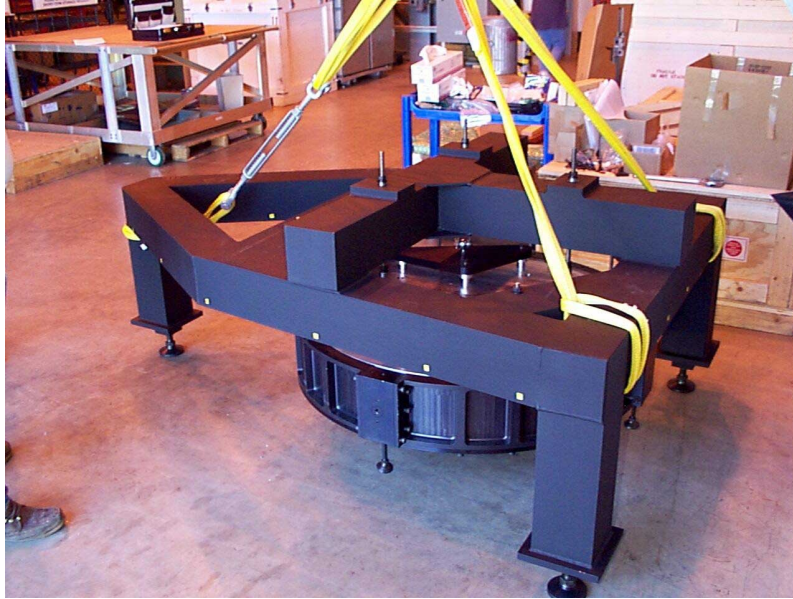
correct the problem by turning the appropriate nuts. The entire lift process takes about 10 minutes.

7. When the AC Flat Collar is about 1" from the Lower Support Frame bottom surface stop lifting.
8. Install four more ½-13 bolts 7.5" long through the Lower Support Frame, then through 4 washers, then into the collar assembly.
9. When sufficiently engaged, remove the original 4 studs, and replace with ½-13 bolts 7.5" long and a 4-washer stackup.
10. Tighten all 8 bolts until the collar assembly is snug against the Lower Support Frame. The torque on the bolts need not be measured, but snug it up with a socket wrench.
11. Install needle roller bearings and shoulder nuts onto the three 30" long studs connected to the Hindle Mounts.

Lifting the AC Flat Support Structure

The mass of the support frames is about 375 pounds. Mass including the AC Flat, Collar Assembly and Hindle Mounts is about 1325 pounds.

1. To lift the AC Flat Support Structure, attach the nylon lifting slings as shown in the picture below:



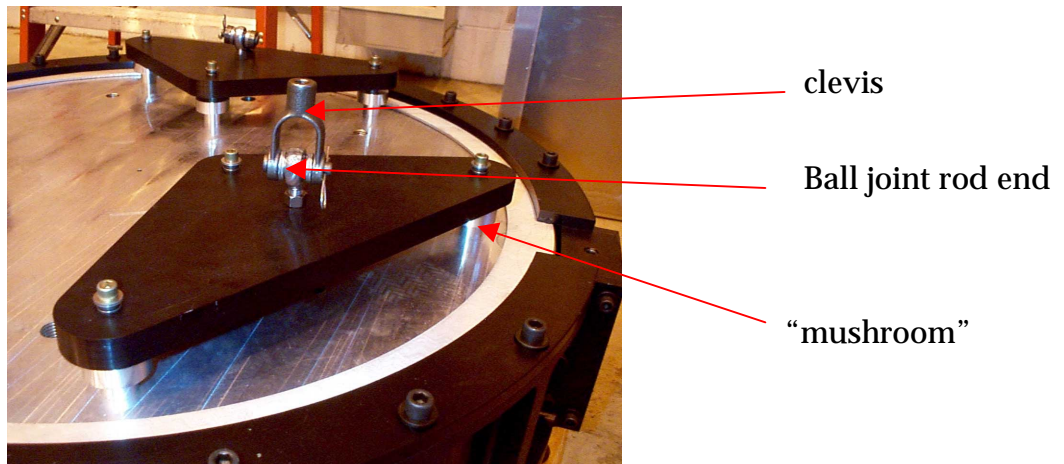
2. Install a turnbuckle (provided) in the path of one nylon strap as shown above.
3. Attach the nylon slings to the crane hook.
4. Raise the structure 1-2 feet and adjust turnbuckle to remove the tilt as shown below:



5. Now the AC Flat Support Structure can be moved.

ACTIVATING AND DEACTIVATING THE HINDLE MOUNTS

The Hindle Mounts were designed to minimize the sag on the mirror caused by gravity. The Hindle Mounts consist of nine Invar mushroom shaped pieces epoxied to the back of the mirror. Three mushrooms are attached to a triangular plate. A ball joint rod end is installed into the triangular plate. A clevis fork goes through the rod end. A long $\frac{1}{2}$ -20 stud attaches to the clevis and goes up through the Upper Support Frame.



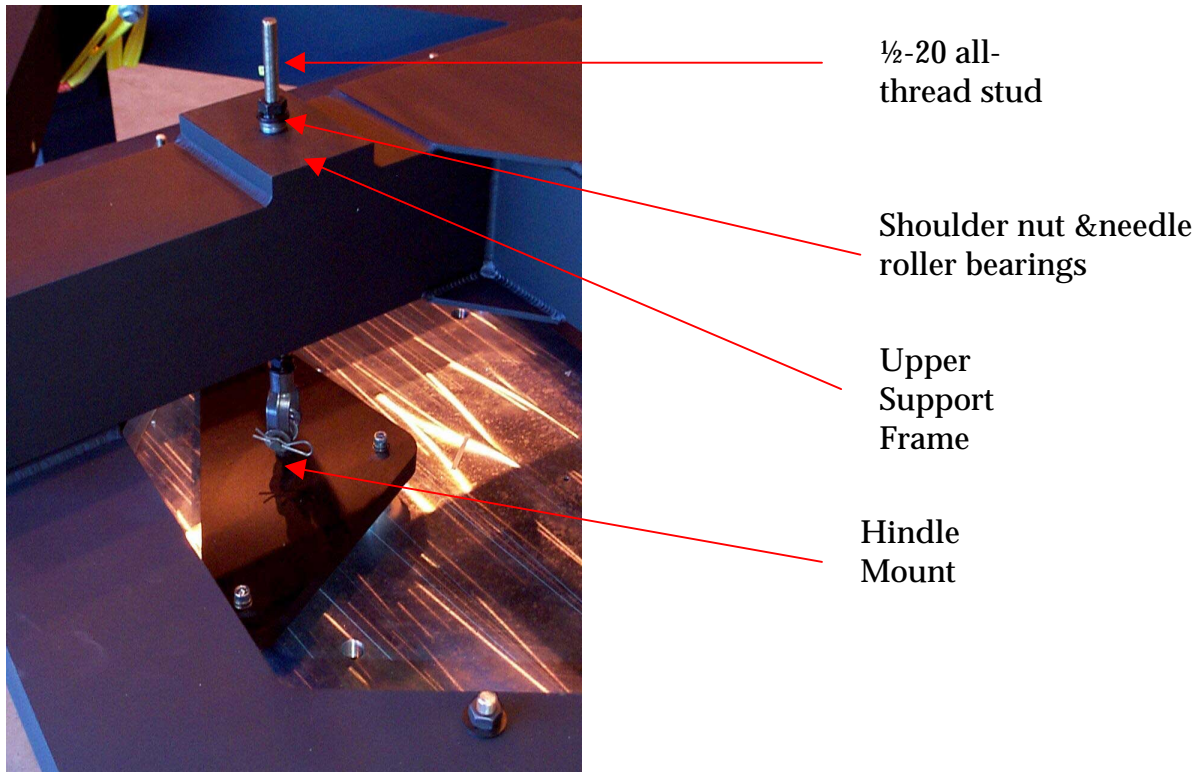
View of Hindle Mount without stud in clevis

When the Hindle Mounts are “activated,” the mass of the AC Flat is held by the three $\frac{1}{2}$ ” diameter studs. The AC Flat is essentially hanging from these three studs. The mass of the Collar Assembly is held via 8 other bolts through the perimeter of the collar and the Lower Support Frame.

When the Hindle Mounts are “deactivated,” the weight of the AC Flat and Collar Assembly is held by the Lower Support Frame.

To activate the Hindle Mount do the following:

1. Verify the upper lip segments are NOT in place on the Collar Assembly.
2. Verify the Collar Assembly is being held via eight $\frac{1}{2}$ -13 bolts around the perimeter of the Lower Support Frame.
3. With three people, slowly rotate the three nuts on the $\frac{1}{2}$ -20 all-thread studs (located on the Upper Support Frame) to raise the AC Flat $\frac{1}{4}$ ” out of the collar.

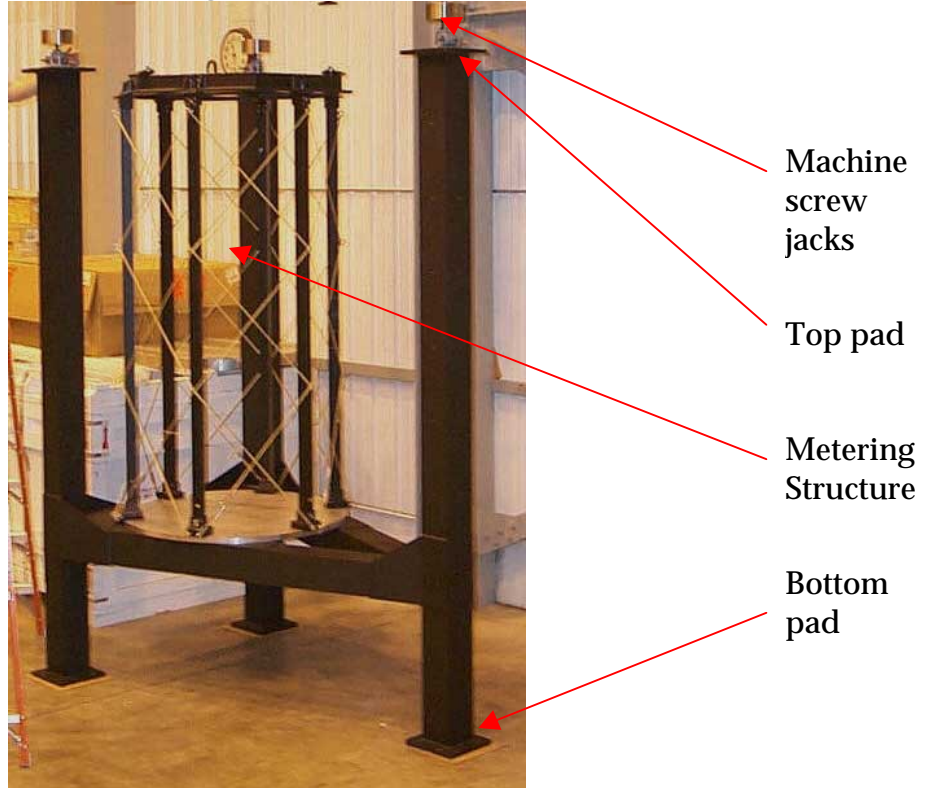


To Deactivate the Hindle Mounts, reverse the process.

TELESCOPE SUPPORT FRAME HANDLING

Lifting the Telescope Support Frame

The Telescope Support Frame weighs 450 pounds.

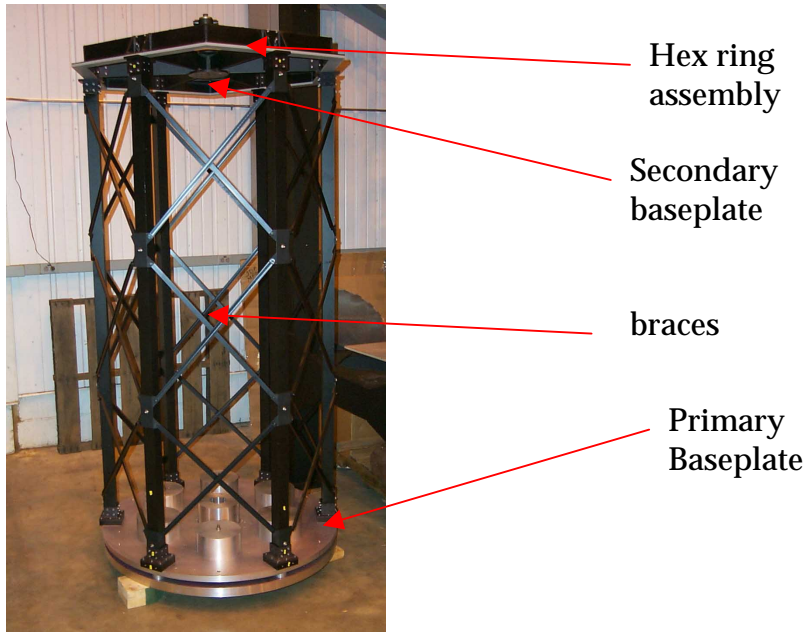


Telescope Support Frame with Metering Structure in place

1. To lift the telescope support frame, remove the three machine screw jacks located on the top of the three pads.
2. Install three lifting plates (provided) on the three top pads.
3. Install hoist rings on the lifting plates
4. Install nylon lifting slings into hoist rings.
5. Move with crane.

TELESCOPE HANDLING

The telescope consists of a primary baseplate to which is attached a metering structure. The primary mirror will be installed onto the primary baseplate, and the secondary mirror will be installed onto the secondary baseplate on the hex ring assembly. The hex ring assembly is attached to the top of the metering structure legs. The total mass of the telescope will be less than 600 pounds. Without the mirrors, the telescope weighs 500 pounds.



Lifting the Telescope Before Mirrors are Installed

Before the primary and secondary mirrors are installed into the telescope, there are more handling options, as follows:

Overhead Crane Lift

1. Install six ½-13 hoist rings in the hex ring assembly on the metering structure
2. Install six hoist rings in the DCATT spreader plate
3. Get three matched nylon slings. Attach one end to a metering structure hoist ring then go up and loop through two adjacent hoist rings on the spreader plate, then go down and connect to an adjacent hoist ring on the metering structure.
4. Repeat for all three slings.
5. Verify that all six hoist rings on the hex ring assembly are being used
6. Lift away. Ensure that the telescope is not tilted.

Forklift/Pallet Jack Operation

1. Place telescope on a standard wooden pallet.
2. Connect to pallet via metal bands or straps.
3. Lift via forklift or pallet jack.

Lifting the Telescope After the Mirrors are Installed

After the primary and secondary mirrors are installed, it is not a good idea to lift the telescope via the upper hex ring because this might misalign the sensitive optics. The best way to lift the telescope is the following:

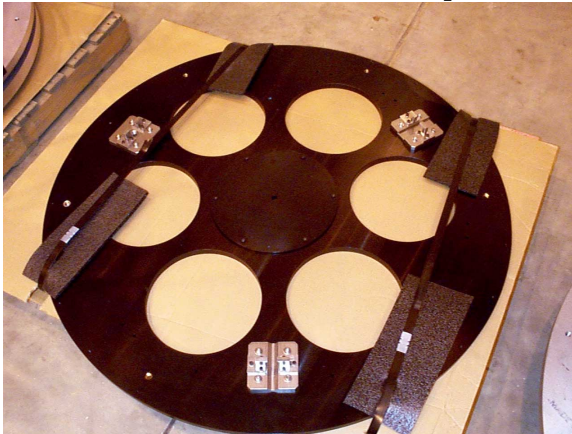
1. Install four ½-13 hoist rings on the primary baseplate perimeter side.
2. Install four matched nylon slings to the hoist rings.
3. Install four ½-13 hoist rings on the DCATT Spreader Plate
4. Attach the nylon slings to the spreader plate hoist rings via clevises
5. Lift away via crane.

BUILDING UP DCATT

The general process of assembling all of the large DCATT assemblies is given here.

Stacking the Frames

1. Put AO Bench Frame into position in the room
2. Install pneumatic isolators per previous procedures
3. Install the AO Bench
4. If optics are on the AO Bench, then consider covering them or removing them for the following operations.
5. Using the overhead crane, install the Telescope Support Frame onto the three pads located on the AO Bench Frame. Use some kind of alignment guides to line up the 8" square bolt hole pattern on the AO Bench Frame pads with the mating pattern on the Telescope Support Frame pads.
6. Once the TSF is down on the pads, bolt the mating pads together with $\frac{1}{2}$ -13 bolts. This is a safety feature and may be removed or loosened if necessary for other operations.
7. At this point, the telescope should be installed onto the Telescope Support Frame. The first hurdle is to optically align the telescope to the optics on the AO Bench. As of 1/19/99, the plan is to use the kinematic mount ring.



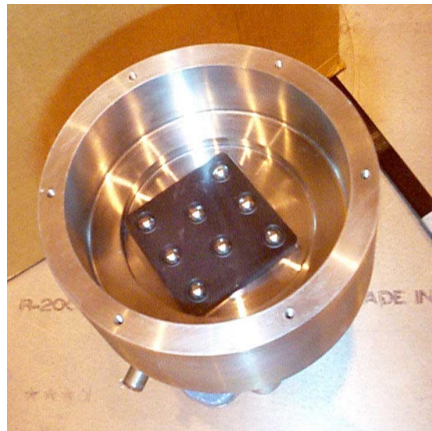
Kinematic Mount Ring

8. This ring and the telescope will be set on the TSF triangle and aligned optically. The telescope's primary baseplate is interfaced to the mount ring via three spherical balls.



One of three kinematic mount interfaces. This is the sphere on V-groove.

9. Once this is accomplished, clamp the ring down. Remove the telescope. Match drill the mount ring to the TSF. Remove the kinematic mount ring and tap the holes with 3/8-16 UNC-2B threadform.
10. Re-install the kinematic mount ring.
11. Re-install the telescope onto the kinematic mount
12. After the telescope is in place, remove the lifting plates from the Telescope Support Frame and install the three machine screw jacks and “dog bowls” onto the three top pads of the Telescope Support Frame.



View into dog bowl showing roller plate

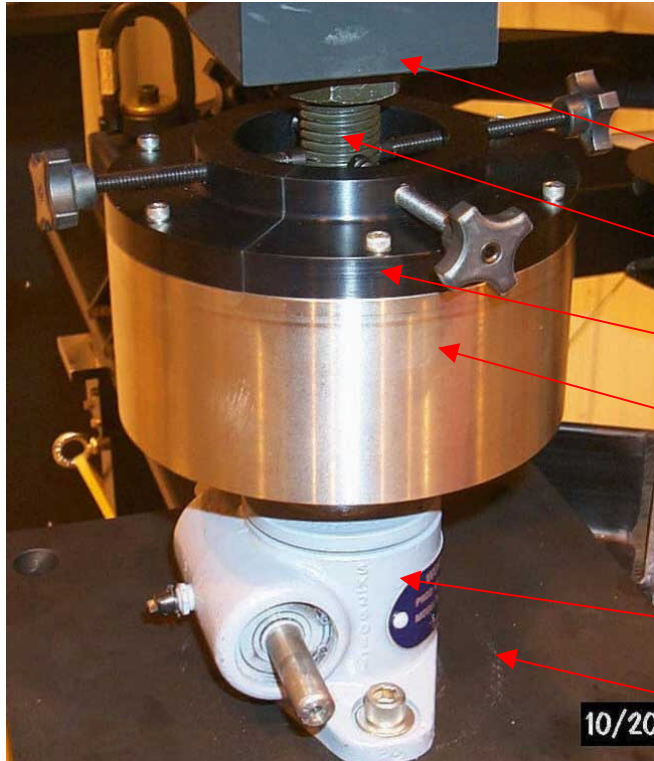
13. Install a roller plate (provided) into each dog bowl.
14. Lift the AC Flat Support Frame above the Telescope Support Frame



15. Slowly lower the AC Flat Support Frame down and fit the three leveling pads into the dog bowls as shown:



16. Install the retaining rings around the leveling pad stud as shown below:



Lower Support Frame leg

Leveling pad stud

Retaining ring

1/4-20 set screws to clamp
leg

1-ton machine screw jack

Telescope Support Frame
top pad

17. Tighten the four set screws around the leveling pad stud. These can be loosened at any time if the AC Flat Support Structure needs to be moved around. Two of the three legs **MUST** be free to move during tilting operations.

VARIOUS ADJUSTMENTS OF THE DCATT ASSEMBLY

The DCATT assembly is very adjustable. Most interfaces and mating subassemblies can be tweaked and moved to accommodate coarse optical alignment and to take up machining tolerances. The following table summarizes the areas of adjustment, degrees of freedom, and the purpose of this adjustment.

INTERFACE	D.O.F.	HOW	WHY
Isolator to Bench Frame	Continuous: Z	pistoning of isolator	Isolate bench from floor vibrations
Bench Frame to AO Bench	Once: X, Y, Z Continuous: 0	via shims during leveling procedure while mating bench to frame.	Level AO bench to bench frame
Telescope Support Frame to Bench Frame	Once: X, Y, rZ Continuous: 0	oversize bolt holes allow 3 dof once during mating of Support Frame to bench frame	Take up fabrication tolerances
AC Flat Support Frame to Telescope Support Frame	Continuous: X, Y, Z, rX, rY, rZ	Ball bearing plate and machine screw jacks provide 6 d.o.f. with limited range of motion.	To control off-axis or FOV adjustment
AC Flat to AC Flat Support Frame via Hindle Mounts	Continuous: rX, rY, Z	Hindle mounts allow limited tip & tilt and inches of piston. NOTE: only pistoning is desirable	Activate & deactivate hindle mount
Telescope to Telescope Support Frame	Once: X, Y, Z, rX, rY, rZ Continuous: rX, rY, Z	6 dof provided once when positioning interface ring manual tip/tilt/piston provided during normal operation via kinematic mount	Adjust focus, leveling, despace, decenter to align telescope to AO Bench
Secondary Mirror Baseplate to Metering Structure	Once: X, Y, Z, rX, rY, rZ	6 dof provided once via shims and oversize mounting holes during mating procedure	Adjust SM decenter
Primary Mirror Segments to Primary Mirror Baseplate	Once: X, Y, Z, rX, rY, rZ Continuous: 0	6 dof provided once during alignment of buckets to primary mirror segments	Take up machining tolerances if desired
Secondary Mirror to Secondary Mirror Baseplate	Once: X, Y, Z, rX, rY, rZ Continuous: 0	6 dof provided once via shims and oversize mounting holes during mating procedure	For alignment adjustment of PM to SM
Primary Mirror Segments	Continuous: 6	via Stewart platform actuators	Part of DCATT experiment plan
Secondary Mirror Segment	Continuous: 6	via Stewart platform actuator	Part of DCATT experiment plan

AO Bench to AO Bench Frame

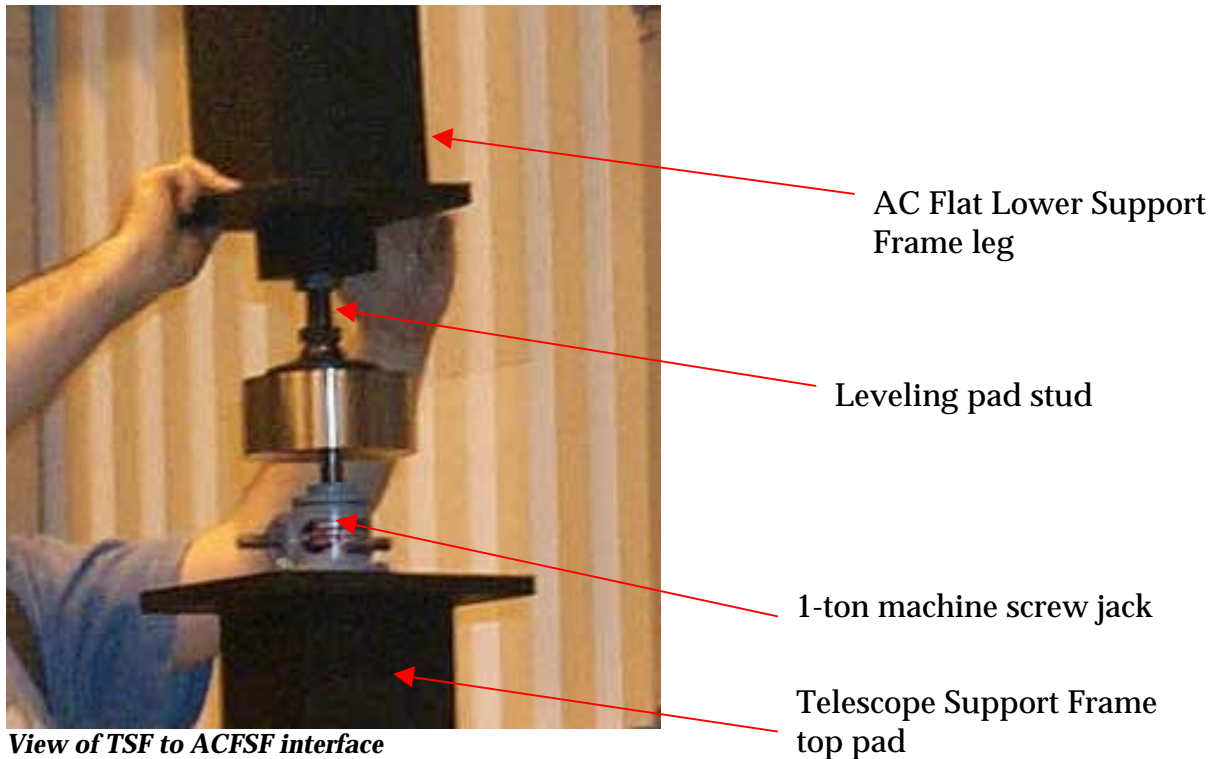
The Bench can be adjusted relative to the AO Bench Frame via the 6 mount plates. The Bench can be tipped, tilted, raised, and translated. The most likely adjustment is to raise the Bench by increasing the mount plate.

Telescope Support Frame to Bench Frame

The TSF can be adjusted relative to the Bench Frame during initial positioning. The mating bolt hole pattern (8" square) was made with 0.75" holes. The mating holes can be offset by as much as 0.25" in X and Y, and clamped with a ½" diameter bolt. For the Z-axis (up and down), shims can be installed between the pads.

AC Flat Support Frame to Telescope Support Frame

The AC Flat is meant to be tilted during various tests of the DCATT optical system. To accommodate this requirement, there are three one-ton machine screw jacks attached to the top of the Telescope Support Frame. The jacks can easily be rotated manually with the handles provided, or electric stepper motors are planned to be added. The jacks have a 100:1 gear ratio, so for every turn, one leg is raised 0.01". Thus for every turn, a tilt of about 30 arc seconds is achieved.



There is a 6" limit to the travel on the jacks. Beyond this limit, the stud could fall out of the jack, and this would be a hazard. Normally the jacks should be used no more than 2" from the bottom of their range of motion. Analysis showed that severe tilts, where one jack is raised 6" and the others are bottomed out, would induce enough stress to shear the jack's stud. A test was safely performed at a 3.75" raise in all the possible combinations of tilts. To limit the travel on the jacks, a hard stop feature is provided.

AC Flat to AC Flat Support Frame via Hindle Mounts

The AC Flat can be raised and lowered via the jacks screws or the hindle mounts. A previous section in this document discussed how to activate and deactivate the hindle mounts.

Note that the AC Flat can be tilted *slightly* using the hindle mounts, but this should be avoided if possible due to inducing side-loads into the epoxied joints on the back of the AC flat. The jack screws should be used for this adjustment.

Telescope to Telescope Support Frame

The Telescope can be adjusted relative to the TSF in several ways. The planned way is to use the adjustable kinematic mount provided on the primary baseplate. This adjustment is a threaded rod going into the primary baseplate. It can be turned to provide tip, tilt, and piston to the entire telescope. The range of motion is at least 0.5”.

Another way to adjust the Telescope in tip, tilt, and piston, is to add shims under the kinematic mount ring.

The way to adjust the Telescope in X and Y is to move the kinematic mount ring and re-bolt it to the Frame. Some match drilling may be involved.

Secondary Mirror Baseplate to Metering Structure

The Secondary Mirror Baseplate attaches to the Metering Structure via a single round plate with a matching bolt hole pattern. If tip, tilt or piston is desired, shims can be added between this interface.

Secondary Mirror to Primary Mirror

The SM can be adjusted in X and Y relative to the PM by moving the Hex Ring Assembly. This assembly is resting on the top of the six metering structure legs. There is about 0.25” of motion available in X and Y. Two to three degrees of rotation is also possible about the optical axis in the same way.

Although this is highly unlikely, it is possible to tip, tilt, and piston the SM relative to the PM by adding shims between the Hex Ring Assembly and the top of the metering structure legs.